NOTES ON SOME LITTLE KNOWN *AMARANTHUS* TAXA (*AMARANTHACEAE*) IN THE UNITED STATES

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ABSTRACT

Amaranthus blitum L. and its infraspecific variability in the United States are analyzed using classical morphological and some new Scanning Electron Microscope characters. Two new combinations within *A. blitum* are proposed, *A. blitum* subsp. *oleraceus* and *A. blitum* subsp. *emarginatus* var. *pseudogracilis*. For the first time, *A. graecizans* L. is confirmed as occurring in North America. Some nomenclatural issues involving *A. blitum* L. and *A. graecizans* L. are also discussed.

RESUMEN

Se analiza *Amaranthus blitum* L y su variabilidad intraespecífica en los Estados Unidos, utilizando los caracteres clásicos y algunos nuevos observados con el Microscopio Electrónico de Barrido. Se proponen dos combinaciones nuevas para *Amaranthus blitum*, *A. blitum* subsp. *oleraceus* y *A. blitum* subsp. *emarginatus* var. *pseudogracilis*. Por primera vez se confirma la presencia de *Amaranthus graecizans* en Norte América. Se analizan también algunos problemas de nomenclatura de *Amaranthus blitum* y *Amaranthus graecizans*.

INTRODUCTION

Many of the roughly 75 species of the genus *Amaranthus* are native to the Americas. Of these, 10 are dioecious (Sauer 1955) and about 40 monoecious. Approximately 10 of these American species are now widespread weeds, some of them being listed among the worst weeds of the world (e.g., *A. retroflexus*, *A. hybridus*, *A. powellii*, and *A. viridis*—Holm et al. 1977; Holm et al. 1997). In return, the Americas have received few species of weedy amaranths from the Old World, though *A. blitum* (subsp. *blitum*) and *A. graecizans* are examples. Among the species introduced to North America, *A. blitum* is especially worthy of attention because in Europe, Africa and Asia it is often a troublesome weed in irrigated crops (Holm et al. 1977; Hügin 1986, 1987; Costea 1998a, b). In the United States, Teitz et al. (1990) stated that in "recent years *A. lividus* (= *A. blitum*) has

become the most serious weed problem in vegetable production in Ohio" in crops such as lettuce, radish, celery and carrot. Furthermore, *A. blitum* is a valuable leaf vegetable crop and is cultivated as such in Asia, Africa, and the Pacific Islands.

After a survey of the 40 of the most important herbarium collections in the United States, as well as the floristic literature, for a revision of the *A. hybridus* complex, it became obvious that *A. blitum* is inadequately understood in North America. This taxon is often confused with *A. viridis* and its infraspecific variability has received no attention.

Likewise, *A. graecizans* is poorly understood in North America. The name *Amaranthus graecizans* has been widely used in North America (e.g., Kearny & Peebles 1960; Hitchcock & Cronquist 1973; McGregor 1986), but has always been misapplied to *A. albus* or *A. blitoides*. In view of this past nomenclatural confusion, the name *A. graecizans* is probably regarded with suspicion by many botanists in North America. We show that this species has been introduced into the United States, and suggest that it may still exist.

The purpose of this paper is not a comprehensive review of the status of these taxa in the United States, but rather to provide the necessary information from which a better understanding of them can develop. To facilitate correct identification, detailed descriptions are provided for each taxon in this species group using both traditional characters and new ones such as trichomes, sculpture of the seed coat and pollen morphology.

The seeds are usually differentiated in a central, convex zone and a marginal, plane zone, exceptions from this rule being rare (*A. blitum* subsp. *oleraceus*). The SEM characters of seeds pertain to the ornamentation of the exotesta in the marginal zone, as observed under 300×, or more magnification. The sculpturing of the seeds is described using the terminology proposed by Barthlott and Ehler (1977). The appearance of the *anticlinal* (prominent or inconspicuous) and *periclinal* (flat, concave or convex with the sculpture of the epicuticular waxes smooth or punctiform) walls of the epidermal cells is noted.

The pollen grains are pantoporate, apolar, small (with D = 18–28 µm) and generally have more than 18 sunken pores, uniformly distributed and having the apertural membrane granulated. The tectum has granules or spinules. See also Eliasson (1988), Nowicke (1993), Costea (1998a,b). Pollen characters include: the diameter of the pollen grain; number and diameter of pores; density of granules or spinules on the tectum according to the following scale: high = 20–30 granules or more/1 μm^2; medium = 10– 19 granules/μm^2 and low = 2–9 granules /1 μm^2. The SEM observations were carried on with a Hitachi S-4100 SEM at 15KV, using a Bio-Rad Sputter-Coatter SC-500.

Some nomenclatural issues with respect to these introduced taxa are discussed as well, including two new combinations

NOMENCLATURE

Amaranthus blitum

Amaranthus blitum and *A. lividus* have been long known to be synonyms (Hooker 1885; Thellung 1914) and the choice between the two names generated an interesting nomenclatural problem, since both taxa were described by Linneus in 1753. Both Moquin-Tandon (1849) and Thellung (1914) considered *A. blitum* to include *A. graecizans*, based on the synonyms they cite under *A. blitum*. Because of this confusion Brenan (1961) stated that the name *A. blitum* should be rejected as *nomen confusum*, and he used instead *A. lividus*. More recently, Brenan and Townsend (1980) proposed explicitly that *A. blitum* be placed on the list of *nomina rejicienda* as *nomen ambiguum*. The Committee for Spermatophyta recommend that *A. blitum* not be rejected (Brumitt 1984). This decision was made on the basis of the fact that "since the last century, and in the present century (*A. blitum*) was used in the correct sense *of A. lividus* or has not been used at all."

In order to establish the priority of two possible legitimate names of equal priority it is necessary to determine which author was the first to unite them. That choice is definitive (Art 57. 2 Berlin Code, Art 11.4 Tokyo Code).

Thellung (1914) selected the name *A. lividus* in which he included:

Amaranthus blitum L. = *Amaranthus lividus* proles *ascendes*—wild plants with prostrate stems and small leaves.

Amaranthus lividus L. = *Amaranthus lividus* proles *lividus* ("typicus")—cultivated forms with vigorous, ascending or erect stems and large leaves, entire plant red-colored.

Amaranthus oleraceus L. = *Amaranthus lividus* proles *oleraceus*—cultivated plants, very much like proles *lividus* but green-colored.

According to Filias et al. (1980) the choice between the two names was made before Thellung (1914) by Hooker in Flora of British India (1885), but in favor of *A. blitum*. Therefore, *Amaranthus blitum* is the valid name and Recommendation 14a of the Tokyo Code (1998) should be followed. Consequently according to Filias et al. (1980) the wild, small-leaved form retains the name *A. blitum* L., being typified by the specimen on the Linnean Herbarium 1117/4. The cultivated forms—*A. oleraceus* and *A. lividus*—are together *A. blitum* var *oleraceus* (L.) Hooker fil., this name being typified by the specimen on sheet 1117/13.

It is interesting that even though the name *A. blitum* has predominantly been used in recent years, the name *A. lividus* it is still employed, even in some recent treatments of the genus (e.g., Townsend 1988; Akeroyd 1993).

Amaranthus graecizans

Linnaeus' phrase name for *A. graecizans*, *A. floribus triandris conglomeratis axillaribus, foliis lanceolatis obtusis*, is appropriate but the geographic source

he reported, Virginia, is incorrect. Uline and Bray (1884) reported from America the following related taxa: *A. blitoides* S. Wats., *A. albus* L., *A. graecizans* L. and *A. blitum* L., included by Moquin-Tandon (1849) in the former genus *Pyxidium*. The two authors observed that the American plants of what was called *A. graecizans* were in fact the same as *A. albus* (supposed to have an American origin) and thus they synonymised the two names, choosing as valid, the first one, which was *A. graecizans*. The nomenclature confusion at that moment was even more complex because as we have shown, at least before Thellung (1914), Moquin-Tandon (1849) was using the name *A. blitum* to designate what we call now *A. graecizans* and other authors (e.g., Hooker 1885) to include both taxa. In such circumstances it is easy to understand why Uline and Bray (1884) were actually able to recognize clearly only *A. blitoides* "*by its four or five sepals, thick at the base, and by the prostrate habit.*" From that point, the idea that *A. graecizans* = *A. albus* persisted in many North American floras even as late as 1986 (McGregor 1986).

Amaranthus graecizans was probably frequently misapplied to *A. blitoides* due to the resemblance between *A. graecizans* subsp. *grecizans* and *A. blitoides*.

In both editions of the checklist of the vascular plants of the United States, Canada and Greenland (Kartesz 1980; Kartesz 1994) *A. graecizans* is no longer listed among the species of the genus *Amaranthus*.

1. Amaranthus blitum L., Sp. Pl. 990. 1753. TYPE: "Habitat in Europa temperatiore"; LINN 1117/4 (the correct specimen, Fillias et al. 1980).

Annual with stems up to 1m, procumbent, ascending to erect, glabrous or with sparse, multicellular, uniseriate hairs. Leaves, 2–8 × 1–5 cm, rhombic-ovate, short-cuneate to truncate at base, shallowly emarginate to obtuse-retuse at apex, somewhat fleshy, green or reddish. Flowers both in axillary cymose clusters and in a terminal variable inflorescence: short, dense and thick to long thin, branched and flexuous. Bracteoles triangular-ovate, shorter than the tepals, with the mid-vein green, usually with two lateral branches. Tepals 3, equal, 1.5–2 mm long and 0.2–0.4 mm wide, linear to (rarely) spatulate. One tepal (rarely 2) with green mid-vein enlarged above the middle, the others entirely membranous, with the mid-vein hardly noticeable. Fruit indehiscent, 1–1.5 mm longer than wide, ellipsoidal to globose, gradually or abruptly-narrowed toward the stigma region. Locule only slightly larger than the seed. Chromosome number: 2n=34.

On the basis of morphology and ecology, three subspecies can be recognized. Although the habitus of plants, morphology of stem and size of leaves usually varies between subspecies (see descriptions), the most reliable characters are the size of seeds and fruits. Also the infraspecific taxa of *A. blitum* can be recognized from the plantlet stage which is uncommon for amaranths, well known to be very difficult to separate in this phenophase.

1. Cotyledons with rounded to truncate apex, 9–18 × 3–6 mm. Pollen grains with pores of 2.4–3.3 µm. Fruit of 1.7–2.6(–3) mm long, with the pericarp 4-layered. Seeds of 1.1–1.8 mm in diameter _____ 2
   2. Cotyledons of 15–18 × 5–6 mm. Bracteoles with the midvein branched. Seeds of 1.2–1.6(–1.9) × 1.2–1.6(–1.9) mm with inconspicuous sculpture and rounded margins _____ subsp. **oleraceus** (Figs. 4, 5C)
   2. Cotyledons of 9–10 × 3 – 3.3 mm. Bracteoles with the mid-vein unbranched. Seeds of (1.1–)1.2 × 1–1.1 mm with evident sculpture and acute margin _____ subsp. **blitum** (Figs. 1, 5A, 5D)
1. Cotyledons with acute apex, 6–7 × 3–6 mm. Pollen grains with pores of 1.6–1.9 µm. Fruit of 1.2–1.8 mm, with the pericarp 3-layered. Seeds of 0.8–1.1 mm in diameter _____ subsp. **emarginatus** (Figs. 2, 3, 5C, 5E)

1a. Amaranthus blitum subsp. **blitum (Fig. 1).** *Albersia blitum* (L.) Kunth, Fl. Berol., ed. 2, 2:144. 1838. *Euxolus blitum* (L.) Gren., Mem. Soc. Emul. Doubs. ser 3, 10:652. 1869. [Flora Jurass. 652. 1869)].

Amaranthus ascendens Loisel., Not. Fl. France 141. 1810. *Amaranthus blitum* L. var. ("b") *ascendens* ("*adscendens*") (Loisel.) DC., Cat. Pl. Horti Monsp. 4. 1813. *Amaranthus lividus* L. proles *ascendens* (Loisel.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus lividus* L. var. *ascendens* (Loisel.) Thell. ex Hayw. & Druce, Advent. Flora Tweedside 177. 1919. *Amaranthus lividus* L. subsp. *ascendens* (Loisel.) Thell. ex Wachter, Heukels, Geill. Schoolpl. Nederl., ed. 11, 169. 1934.

Amaranthus viridis auct., non L.

The plants are normally green. The stem procumbent to ascending and without prominent ribs. Cotyledons lanceolate, 9–10 × 3–3.3 mm, with rounded apex and cuneate base; petiole 4–5 mm. Fruit, 2 mm long, when fresh with the pericarp almost smooth, when dried irregularly wrinkled in the zone with the seed, the rest of the fruit being smooth. Stigma branches, thin (0.9–1.1 mm long and 0.2–0.25 mm wide at the base) often no longer observable when the fruit is dried. Seeds, (1.1–)1.2 × 1–1.1 mm, broad-ovate to circular, differentiated into central and marginal zones. The marginal zone sculptured with the cells of the exotesta polygonal, 25–40 µm length, with the anticlinal walls prominent and the periclinal walls plane and minutelly punctiform sculptured (Fig. 5A). The margin of the seed acute. Color dark—brown to black with the marginal zone usually paler. Pollen grains 19–23 µm with 32–45 pores of 2.4–3.3 µm diameter (Fig. 5D).

Distribution and ecology.—Native to Mediterranean region, Eurasia and North Africa where it was cultivated as a potherb until the 18th century, when it was largely replaced by *Spinacia oleracea*. In these regions it is a frequent weed in vegetable gardens, and in waste places. In the United States this name was usually misapplied to *A. blitum* subsp. *emarginatus* which is more frequent. Subspecies *blitum* appears casually in waste places in urban settings. The only herbarium specimen seen from the United States was: **New York**. Central Park, 1861, *Austin s.n* (GH).

1b. Amaranthus blitum subsp. **emarginatus** (Moq. ex Uline & Bray) Carretero,

FIG. 1. *Amaranthus blitum* subsp. *blitum*.

Munoz Garmendia & Pedrol, Ann. J. Bot. Madrid 44:599. 1987. *Amaranthus emarginatus* Moq. ex Uline & Bray, Bot. Gaz. (Crawfordsville) 19:319. 1894. TYPE: INDONESIA: "*Amaranthus polygonoides* L. ?, Java, 1842–44, *Zollinger 1646*" (LECOTYPE: P; ISOLECTOTYPE: Fl. G, STR; cf. Hügin 1987. 461).

Euxolus viridis L. var. (e) *polygonoides* Moq., DC., Prodr. 13(2):273. 1849. *Amaranthus ascendens* Loisel. var. *polygonoides* (Moq.) Thell., Mem. Soc. Sci. Nat. Cherbourg 38:215. 1912. *Amaranthus lividus* L. proles *polygonoides* (Moq.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus lividus* L. var. *polygonoides* (Moq.) Thell. ex Druce, Bot. Soc. Exch. Club Brit. Isles 5:574. 1920. *Amaranthus lividus* L. subsp. *polygonoides* (Moq.) Thell. ex Probst, Wolladventivfl. Mitteleur. 74. 1949. *Amaranthus ascendens* subsp. *polygonoides* (Moq.) Thell. ex Priszter, Agartud. Egyet. Kert- Szologazdasagtud. Karanak Evk. 2:221. 1953. *Amaranthus blitum* subsp. *polygonoides* (Zollinger ex Moq.) Carretero, Ann. J. Bot. Madrid 41:276. 1985.

Similar to *Amaranthus blitum* subsp. *blitum*, differing in the following characters: slender stems, up to 70 cm long, prostrate to ascending. Cotyledons narrow-elliptic, 6–7 × 2–2.3 mm with acute apex and base; petiole about 4 mm long. Leaves not fleshy, long-cuneate at base and deeply emarginate to bilobed at apex. Tepals 2(–3)0.75–1.5(–1.8) mm long, obtuse. Fruit longer than the tepals, globose to ovoid (1.0–)1.2–1.8(–2.0) mm long, 1–1.5 mm longer than wide, evidently larger than the seed. Seeds 0.8–1.1 × 0.8–1.1 mm, circular, with the hilum prominent on the outline of the seed. The marginal zone more evidently sculptured than in subsp. *blitum* (Fig. 5B). Pollen grains as in subsp. *blitum* but pores of 1.4–1.8 μm in diameter (Fig. 5E). Chromosome numbers: 2n=34. The appropriate rank of this taxon requires further investigation. Hügin (1986, 1987) and Costea (1998a,b) treated it as a species.

The habit of the plants is variable:

1. Prostrate plants, leaves (0.75–)1–2(–3.5) cm long; inflorescence entirely formed from axillary cymes (terminal part absent or reduced _____ var. **emarginatus**
1. Ascending more vigurous plants with leaves 2–4(–6) cm long, inflorescence mainly terminal, long, thin, flexuous _____ var. **pseudogracilis**

a. Amaranthus blitum subsp. **emarginatus** Moq. ex Uline & Bray var. **emarginatus** (**Fig. 2**).

b. Amaranthus blitum subsp. **emarginatus** var. **pseudogracilis** (Thell.) Costea, comb. et stat. nov. (**Fig. 3**). BASIONYM: *Amaranthus lividus* L. proles *polygonoides* f. *pseudogracilis* Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus emarginatus* subsp. *pseudogracilis* (Thell.) Hügin, Willd. 16: 463. 1987. TYPE: "im Botanischen Garten Strasburg," 8.8 1904, *A. Ludwig 12130* (B) specifying "Unter dem falschen Namen *Euxolus caudaus*."

Amaranthus viridis auct., non L.

Distribution and Ecology.—Native to and very widespread in the tropics, but also introduced into the warm temperate regions of North America and Europe. The two wild subspecies are partially sympatric, but are separated ecologically, subsp. *emarginatus* being more demanding of warm climates than subsp. *blitum*. The varieties of subsp. *emarginatus* are further ecologically sepa-

FIG. 2. *Amaranthus blitum* subsp. *emarginatus* var. *emarginatus*.

FIG. 3. *Amaranthus blitum* subsp. *emarginatus* var. *pseudogracilis*.

rated in that variety *emarginatus* grows preferentially on sandy alluvium on the banks of rivers, on lakeshores and beaches, while variety *pseudogracilis* is found mostly as a weed in irrigated vegetable crops and nurseries. This subspecies is the most widespread form of *A. blitum* found in the United States.

Representative specimens examined for var. *emarginatus*: **FLORIDA. Dade Co.:** Key Biscayne, Cape Florida State Park, 15 Mar 1969, *Gillis 7688* (A). Homestead, Bay Front Park, 5 Nov 1977, *Correll and Popenoe 49092* (A). **Hillsborough Co.:** 12 mi SE of Tampa ("beach area"), 28 Oct 1960, *Ray et al 10605* (GH). **Leon Co.:** Tallahassee, Lake Ella, 10 Jul 1986, *Anderson 9737* (BRIT). Near F.S.U. campus, 6 Oct 1994, *Anderson 15283* (BRIT). 30 Oct 1976, *Brumbach 9087* (GH). **Manatee Co.:** 20 mi E of Bradenton, 27 Apr 1975, *Genelle and Fleming 2040* (RSA, FLAS). **LOUISIANA. Parish Calcasieu:** 4 mi S of Lake Charles, 13 Jul 1969, *Thieret 31617* (SMU). **Massachusetts. Hampshire Co.:** University of Massachusetts campus, Amherst, 17 Sep 1966, *Ahles 64683* (SMU). **NEW YORK. Bronx Co.:** New York, 26 Sep 1937, *Moldenke 10534* (VDB). **Madison Co.:** shore of Oneida Lake, Lewis Point, 14 Sep 1938, *House 26133* (GH). **NORTH CAROLINA. Duplin Co.:** 2 mi W of Greenevers (weed in broccoli) 15 Oct 1991, *Wilbur 59784* (DUKE). **PENNSYLVANIA. Bradford Co.:** shore of Susquehanna River at Homets Ferry, 3 Sep 1962, *Wahl 20220* (GH). 14 Aug 1955, *Wahl 16564* (GH). **Travis Co.:** at Hornsby Bend Sewage treatment Plant (Montopolis Quadrangle), 19 Apr 1986, *Carr 7281* (TEX).

Representative specimens examined for var. *pseudogracilis*: **FLORIDA. Alachua Co.:** Gainesville, University of Florida Campus, 13 Oct 1967, *D'Arcy 2197* (FW). **Lee Co.:** Eastern Sanibel, 20 Oct 1976, *Brumbach 9077* (BRIT). 21 Nov 1972, *Brumbach 8110* (GH). **TEXAS. Orange Co.:** Orange, 55 May 1937, *Cory 22306* (A). **MISSOURI. Cape Girardeau Co.:** Cape Girardeau weed in green house, *Brooks 7868* (VDB). **PENNSYLVANIA. Philadelphia Co.:** Holmesburg, 2 Jul 1942, *Long 58418* (GH). **NEW YORK:** grounds of New York Botanical Garden, 13 Oct 1984, *Nee 30150* (TEX).

1c. Amaranthus blitum subsp. **oleraceus** (L.) Costea, comb. nov. (**Fig. 4**). BASIONYM: *Amaranthus oleraceus* L., Sp. Pl., ed. 2, 1403. 1763. TYPE: LINN 1117/3.

Euxolus oleraceus (L.) Moq., DC., Prodr. 13(2):273. 1849. *Albersia oleracea* (L.) Boiss., Fl. Or. 4:991. 1879. *Albersia blitum* var. *oleraceus* (L.) Hooker fil., Fl. Brit. Ind. 4:721. 1885. *Amaranthus lividus* L. proles *oleraceus* (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914. *Amaranthus ascendens* Loisel. var. *oleraceus* (L.) Thell. ex Priszter, Agartud. Egyet. Kert- Szologazdasagtud. Karanak Evk. 2:221. 1953. *Amaranthus lividus* subsp. *oleraceus* (L.) Soó, Acta Bot. Sci. Hung. 10:376. 1964.

Amaranthus lividus L., Sp. Pl. 990. 1753. *Euxolus lividus* (L.) Moq., DC. Prodr. 13(2):273. 1849. *Amaranthus lividus* L. proles *lividus* ("typicus") (L.) Thell., Ascherson & Graebner, Syn. Mitteleur. Fl. 5:321. 1914.

We present this taxon for comparison and because it is a potentially valuable vegetable, though it appears not to have yet been used for this purpose in North America.

It is very much like subsp. *blitum* but differs in the following characters: the plants are green to purple. The stem is erect, very thick, strongly ribbed. Cotyledons narrow, ovate to lanceolate, 15–18 × 5–6 mm, with rounded or truncate apex and acute base; petiole 10–12 mm long. Fruit 2.3–3.5 mm, when dry with the pericarp coarsely wrinkled. Stigmas branches well-developed (2 mm long and 0.5–0.6 mm wide at the base) and persistent when the fruit is dried. Seeds 1.2–1.6(–1.9) × 1.2–1.6(–1.9) mm, circular, not differentiated into central and marginal zones. The sculpture of the margin is inconspicuous at <100 × magnification. The cells of the exotesta in the marginal zone often inconspicuous

FIG. 4. *Amaranthus blitum* subsp. *oleraceus*.

(the anticlinal walls are inconspicuous) with the periclinal walls less punctiform sculptured than in subsp. *blitum* (Fig. 5 C). Margin of the seed rounded. Color dark-brown to blackish, uniform. Pollen as in subsp. *blitum*.

Originated as a selection of *A. blitum* subsp. *blitum* and exists only as a cultivated vegetable. The only herbarium specimens of *A. blitum* subsp. *oleraceus* seen from U.S. were those of the accessions PI 606281 and PI606282 cultivated at Ames, Iowa (originally from Bangladesh). Chan (1996), Chan and Sun (1997) refer to these accessions as "unidentified species—AMES 5366." Based on molecular techniques the authors separate it both from *A. blitum* and *A. tricolor*. Unfortunately the accession PI 288277 used by the authors (Chan 1996; Chan & Sun 1997) as "*A. lividus*" (= *A. blitum*) and the others from India—Ames 5123, 5146, 5315, 5387, PI 271465, PI 288277 and PI 608661—do not belong for sure to *A. blitum*. All these plants are related to *A. tricolor* as circumscribed by Aellen (1959). These results show that the complex *A. tricolor* is still poorly understood and a revision of the group is necessary. For future studies we recommend the germplasm collection of the U.S. National Plant Germplasm System *http://www.ars-grin.gov*.

2. Amaranthus viridis L. Sp. Pl., ed. 2, 1405. 1763. TYPE: "Habitat in Europa, Brasilia," LINN 1117/15.

Amaranthus gracilis Poiret, Lam., Encycl. Suppl. 1:312. 1810.

Annual, with stem up to 1 m tall, ascending to erect, glabrous to sparsely pubescent above, the trichomes being multicellular and uniseriate. Cotyledons lanceolate, 12 × 2.5 mm, with acute apex and acute to decurrent base; petiole 5–6 mm long. Leaves 3–8 × 2–5 cm, rhombic-ovate, entire to shallowly emarginate at apex. Inflorescence mostly terminal, long, thin, flexuous, ramified or not. Bracteoles about 1mm long, acute, triangular-ovate, shorter than the tepals. Tepals 3, equal, 0.8–1.5 × 0.3–4 mm, bent along the fruit, narrow-spatulate to narrow-obovate, with the mid-vein green, enlarged above the middle. Fruit indehiscent, 1.2–1.5 mm, ellipsoidal to globose, usually gradually narrowed toward the stigma branches. As a rule, the pericarp is strongly wrinkled, muricate, but sometimes almost smooth. Stigma branches thin (0.9–1.1 mm long and 0.05–0.075 mm wide at the base). Seeds 1–1.2 × 0.9–1.1mm, circular with an inconspicuous hilum, differentiated into central and marginal zones. The margin of the seed is acute. The sculpture of the seeds is variable, two "types" being possible:

1) Seeds entirely verrucose.
2) Seeds with inconspicuous sculpture, resembling *A. blitum* subsp. *oleraceus*.

On the basis of the verrucose seeds, Kowal (1954) circumscribed the Section *Puncticulate* that includes *A. viridis* and *A. acutilobus*. Because this characteristic varies within a species, it is evidently that the section *Puncticulate* created by Kowal can not be recognized.

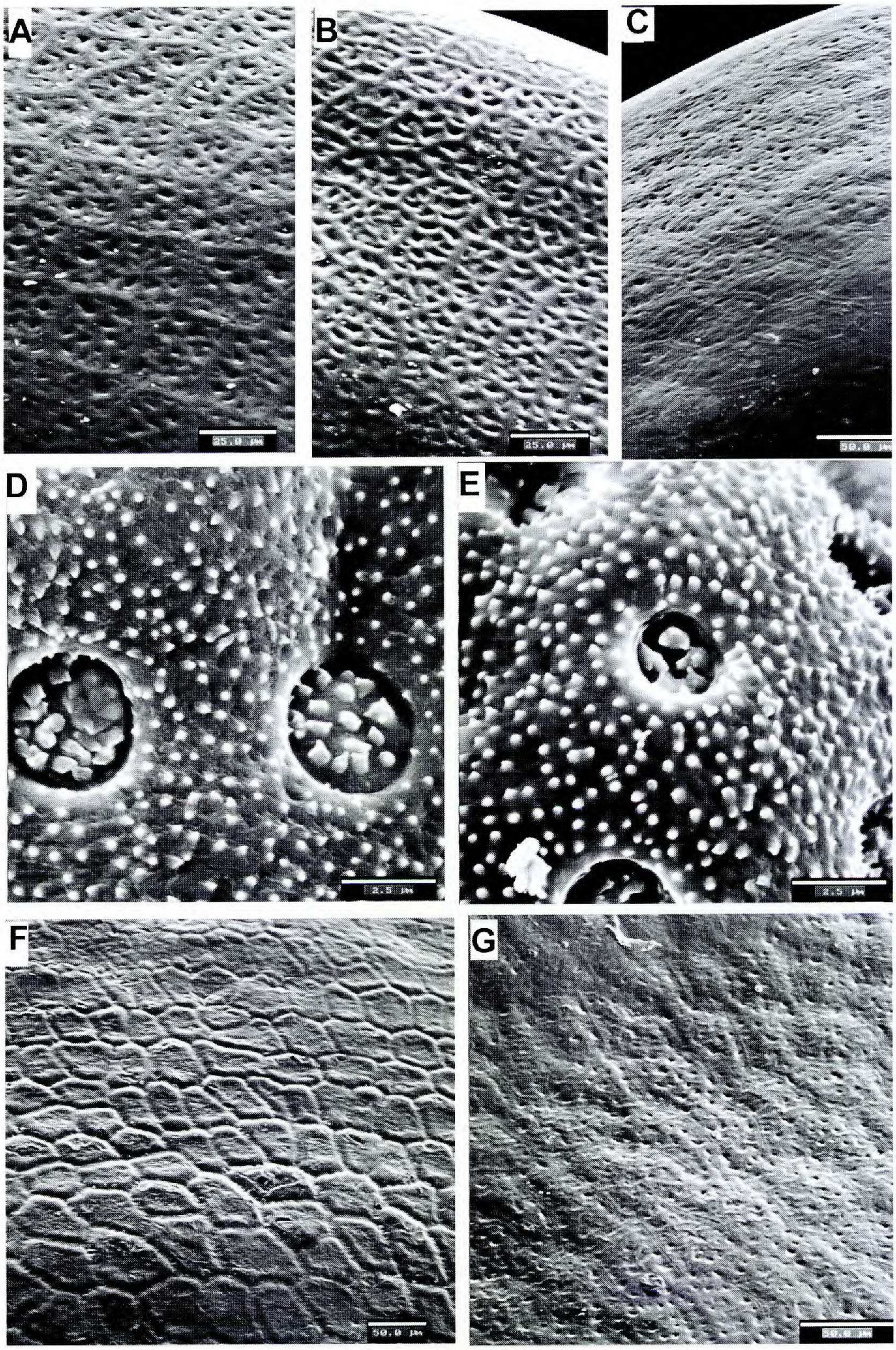

FIG. 5. A–C. Surface of exotesta on the seed margin. A. *Amaranthus blitum* subsp. *blitum* (scale bar 50 μm); B. *A. blitum* subsp. *emarginatus* (scale bar 25 μm); C. *Amaranthus blitum* subsp. *oleraceus* (scale bar 50 μm). D–E. Pollen (scale bar 2.5 μm). D. *Amaranthus blitum* subsp. *blitum*; E. *Amaranthus blitum* subsp. *emarginatus*. F–G. Surface of exotesta on the seed margin. (scale bar 50 μm). F. *Amaranthus graecizans* subsp. *graecizans*; G. *Amaranthus graecizans* subsp. *sylvestris*.

Pollen grains 18–20 µm with 32–40 pores of 1.9–3.2 µm diameter. Density of granules medium. Brenner observed (unpublished) that plants grown in the green house produce abundant nectar.

The name *A. viridis* is sometimes misapplied to *A. blitum* in North America. For the nomenclature and typification of *A. viridis* see Thellung (1914), Merril (1936), Coons (1975, 1981). Even though related to *A. blitum*, *A. viridis* is unquestionable a distinct species.

Distribution and ecology.—Native to South America according to the majority of authors, but "possibly of Asian origin" (Townsend 1988). This is practically a cosmopolitan noxious weed in the tropical and subtropical regions of the world. It has been introduced into the warmer temperate regions of Europe, North America, Asia, Africa and Australia.

Representative specimens examined: **MISSISSIPPI. Washington Co.:** just NE of Leland, 1 Sep 1990, *Bryson 10315* (IBE). **SOUTH CAROLINA. Richland Co.:** Columbia, 22 Aug 1971, *Leonard et al. 4939* (SMU). **TEXAS. Arkansas Co.:** Rockport, 5 Jun 1958, *D. S. & H. B. Correll 18948* (LL). **Brazoria Co.:** San Bernard Refuge, 11 Aug 1969, *Fleetwood 9539* (TEX). **Brazos Co.:** College Station Texas, 29 Nov 1949, *Parmalee 91* (TEX). **Calhoun Co.:** Matagorda Isle, 19 Jul 1973, *Hartman et Smith 3648* (TEX). **Harris Co.:** Houston, 10 Jun 1958, *Traverse 747* (LL). **Travis Co.:** 30°16'43"N, 97°29'00"W, 140m, 16 Jun 1996, *Carr 15530* (TEX). Austin, 23 May 1986, *Carr 7466* (TEX). **Webb Co.:** Laredo, 8 Apr 1965, *Cuesta 22* (LL).

3. Amaranthus graecizans L., Sp. Pl. 990. 1753. TYPE: "Habitat in Virginia"; LINN 1117/3.

Annual with erect to ascendant stems, up to 80 cm, in the upper part with trichomes like *A. blitoides* [uniseriate trichomes consisting from 2(–3) cells with the terminal cells spherical, much larger than the basal one], in addition multicellular uniseriate trichomes are present. Leaves 2–4(–5) × 1–3 cm linear, lanceolate to rhombic—ovate or rhombic-elliptic, without a conspicuous hyaline margin. Bracteoles equal to or longer than the tepals with the mid-vein ramified. Tepals 3, 1.5–2 mm long, elliptic to lanceolate-oblong, gradually or abruptly narrowed into a mucro, with the mid-vein ramified. Fruit usually circumscissile (sometimes indehiscent), (2–)2.2–2.5(–2.7) mm, broad-ellipsoidal to globose, gradually narrowed toward the stigma region, with the dehiscence line in the lower part, strongly-wrinkled. Stigmas 2–2.25 mm long and 0.4–0.6 mm thick at the base. Seeds circular, 1.0–1.3 × 1.0–1.3 mm, lenticular, with a short furrow above the hilum, differentiated into central and marginal zones. Margin of the seed acute. Pollen grains 21–25 µm with 19–32 pores of 1.5–1.7 µm in diameter. Density of granules medium. Chromosome number: 2n=32.

Amaranthus graecizans differs from *A. albus* in not having spinescent bracteoles and by its larger seeds. From *A. blitoides* it can be distinguished by the erect or ascendant stems, possession of only 3 tepals, the absence of a hyaline margin on the leaf blades and by its smaller seeds.

Native in the Mediterranean region, including North Africa. The two widespread subspecies differ in leaf shape and seed sculpture.

1. Leaf blade lanceolate, usually 1–1.5 cm broad; marginal zone of the seeds with prominent cells whose periclinal walls are smooth (Fig.5F) _____ **A. graecizans** subsp. **graecizans**

1. Leaf blade rhombic-ovate to ovate-elliptic, up to 4 cm broad; marginal zone of the seeds with inconspicuous cells, whose periclinal walls are minutely punctiform sculptured (Fig. 5G) _____ **A. gracizans** subsp. **sylvestris**

3a. **Amaranthus graecizans** subsp. **graecizans**

Amaranthus angustifolius Lam., Encycl. 1:115. 1783., nom. illeg.

3b. **Amaranthus graecizans** subsp. **sylvestris** (Vill.) Brenan, Watsonia 4:273. 1961. (**Fig. 6**).

Amaranthus angustifolius Lam. var. *sylvestris* (Vill.)Thell. in Schinz & Keller, Fl. Schweiz ed. 4, 1:222. 1923. *Amaranthus sylvestris* Vill., Cat. Pl. Jard. Strasbourg 111. 1807. *Amaranthus graecizans* var. *sylvestris* (Vill.) Ascherson in Schweif., Beitr. Fl. Aethiop. 176. 1867.

Distribution and ecology.—*A. graecizans* subsp. *graecizans* is found in the warmer regions of Europe, through most of Africa and in tropical Asia, especially India. Plants belonging to subsp. *sylvestris* have generally the same range as subsp. *graecizans* but penetrate into the cooler regions of Europe, southwest Asia and northwest India. Another subspecies—subsp. *thellungiacus* (Nevski) Gusev, having leaf-blades narrowly linear or lanceolate to rhomboid spathulate and long-aristate tepals and bracteoles, awns 0.3–1 mm, divergent, has a more restricted range: Middle Asia, India and also sporadically introduced in Africa (Townsend 1988).

In the United States we have seen only 2 specimens belonging to subsp. *sylvestris*, both from NEW JERSEY. Camden Co.: Camden, "on ballast," 9 Aug 1879, *Parker s.n.* (RSA); same location, 30 Aug 1879 *Parker s.n.* (RSA). It is almost certain that this plant is more widespread than these collections suggest, being probably under collected or misidentified as *A. blitoides* (especially with var. *reverchonii*) or *A. albus*. Also, there are numerous herbaria that we did not survey for this species group as it was not a primary focus of our research.

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FIG. 6. *Amaranthus graecizans* subsp. *sylvestris*, *Parker s.n.* (RSA).

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